

INTRADERMAL JET INJECTION ELECTROPORATION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application is a divisional of U.S. patent application Ser. No. 16/066,919, filed Jun. 28, 2018, now allowed, which claims priority to the National Stage Application of International Patent Application No: PCT/US2016/068972; filed Dec. 28, 2016, which claims priority to U.S. Provisional Patent Application No. 62/271,969, filed Dec. 28, 2015. The above referenced applications are hereby incorporated by reference.

BACKGROUND

[0002] The present disclosure relates to, among other things, a portable, hand-held device capable of using a needle-free jet injection and electroporation combination device to deliver an agent to a subject

SUMMARY

[0003] Needle-free jet injection enables the delivery of a drug without the use of an invasive hypodermic needle, whereby a jet of liquid is accelerated to a high speed. As a result the jet injection provides enough power for the liquid to penetrate the stratum corneum of a subject's skin.

[0004] Electroporation is the use of a transmembrane electric field pulse to induce microscopic pathways (pores) in a bio-membrane. These pores are commonly called "electropores."¹ Their presence allows an agent to pass from one side of the membrane to the other. Thus, electroporation has been used to introduce drugs, DNA or other molecules into multi-cellular tissues, and may prove to be effective for the treatment of certain diseases.

[0005] There is a need in the art to provide a means for effectively delivering an agent via jet injection and subsequently being able to electroporate in a single portable, hand-held, self-contained device.

[0006] In one aspect, an electroporation device for use with an agent cartridge defining a volume containing a pre-measured dose of agent therein. The electroporation device including a housing having an axis extend there-through, a nozzle at least partially positioned within the housing, a cavity sized to receive at least a portion of the agent cartridge therein and where the nozzle is in fluid communication with the volume of the agent cartridge when the agent cartridge is positioned within the cavity, an array having a plurality of electrodes extending therefrom, a propulsion cartridge configured to operatively engage the agent cartridge when the agent cartridge is positioned within the cavity, and a power supply in electrical communication with the array.

[0007] In another aspect, an electroporation device for use with an agent cartridge defining a volume containing a pre-measured dose of agent therein. The electroporation device including a housing defining a cavity sized to receive at least a portion of the agent cartridge therein, a nozzle at least partially positioned within the housing and in fluid communication with the agent cartridge when the cartridge is positioned within the cavity, a propulsion rod positioned at least partially within the housing and movable with respect thereto between an armed position and a deployed position, and where movement of the propulsion rod from

the armed position to the deployed position expels at least a portion of the pre-measured dose of agent through the nozzle, a propulsion spring extending between the propulsion rod and the housing, the propulsion spring configured to bias the propulsion rod toward the deployed position, an array having one or more electrodes extending therefrom, a power supply, and a trigger assembly. Where the trigger assembly is adjustable between a first configuration, where the propulsion rod is fixed in the armed position and the power supply is not in electrical communication with the array, and a second position, where the propulsion rod is free to move between the armed and deployed positions and the power supply is in electrical communication with the array.

[0008] In still another aspect, an electroporation device including a cartridge defining a volume having a pre-measured dose of agent therein, at least a portion of the volume being sealed off by a plunger, and a jet injection module. The jet injection module including, a first housing defining a cavity sized to receive at least a portion of the cartridge therein, a nozzle at least partially positioned within the housing and in fluid communication with the cartridge when the cartridge is positioned within the cavity, and an array having one or more electrodes extending therefrom, where the array is movable with respect to the first housing between a retracted position, where the electrodes are positioned within the housing, and an extended position, where at least a portion of the electrodes are positioned outside the housing. The jet injection module also including a base assembly being removably couplable to the jet injection module. The base assembly including a propulsion rod positioned at least partially within the housing and movable with respect thereto between an armed position and a deployed position, and where the propulsion rod is configured to operatively engage the cartridge, a propulsion spring extending between the propulsion rod and the housing, the propulsion spring configured to bias the propulsion rod toward the deployed position, a power supply, and a trigger assembly adjustable between a first configuration, where the propulsion rod is fixed in the armed position and the power supply is not in electrical communication with the array, and a second position, where the propulsion rod is free to move between the armed and deployed positions and the power supply is in electrical communication with the array.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is an exploded side view of a jet injection system in accordance with an embodiment of the present disclosure.

[0010] FIG. 2 is an exploded side view of a base assembly (as well as an embodiment of a propulsion cartridge) in accordance with an embodiment of the present disclosure.

[0011] FIG. 3 is an exploded side view of a jet injection module in accordance with an embodiment of the present disclosure.

[0012] FIG. 4 is an exploded side view of a propulsion cartridge in accordance with an embodiment of the present disclosure.

[0013] FIG. 5 is an exploded side view of a jet injection and electroporation (EP) delivery device in accordance with an embodiment of the present disclosure as well as a cartridge.

[0014] FIG. 6 is an exploded side view of a jet injection module and EP array assembly combination in accordance with an embodiment of the present disclosure.